

Strategic High Altitude Infrared Backgrounds

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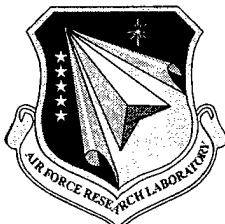
15 Jan 2001

Final Report

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20030220 046

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
	January 15, 2001	Final Report, 10 June, 1993 - 28 February 1999	
4. TITLE AND SUBTITLE Strategic High Altitude Infrared Backgrounds		5. FUNDING NUMBERS PE: 63215C PR: S321 TA: GD WU: AD Contract F19628-93-C-0040	
6. AUTHOR(S) W. O. Gallery, H. E. Snell and J.-L. Moncet			
7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES) Atmospheric and Environmental Research, Inc. 131 Hartwell Avenue Lexington, MA 02412		8. PERFORMING ORGANIZATION REPORT NUMBERS Project No. P-519	
9. SPONSORING / MONITORING AGENCY NAMES(S) AND ADDRESS(ES) Air Force Research Lab 29 Randolph Road Hanscom AFB, MA 01731-3010 Contract Manager: Dean Kimball		10. SPONSORING / MONITORING AGENCY REPORT NUMBER AFRL-VS-TR-2001-1604	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited		12b. DISTRIBUTION CODE	
13 ABSTRACT (Maximum 200 words) The purpose of this contract was to "...provide models and codes to predict infrared background phenomenon to be encountered by advanced space based systems operating in natural and disturbed backgrounds." The three specific tasks of the contact were: (1) analysis data from the Mid Course Space Experiment (MSX), (2) development of advanced radiance inversion techniques, and (3) enhancement of the radiative transfer program FASCODE Environment (FASE). Under (1), AER developed experiment plans and detailed data collection event parameters for MSX to obtain vertical profiles of radiance and trace gases in the stratosphere. In addition, AER analyzed data from meteorological satellites coincident with MSX measurements and correlated these data with the MSX data. In (2), AER collaborated with PL/GPOS to analyze radiance data from CIRRIS-II. by enhancing and applying the fast radiative transfer code XFWD and the inversion INV. In (3), AER continued the development of the atmospheric radiative transfer code FASCODE . The new code is called FASE, for FASCODE for the Environment.			
14. SUBJECT TERMS MSX, FASE, CIRRIS-II, FASE, FASCODE, Atmospheric radiance, Infrared, Backgrounds, Remote sensing, Inversion, Trace gases		15. NUMBER OF PAGES 9	
		16. PRICE CODE Z	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR

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1. Introduction

As stated in the Phillips Lab PRDA, the goal of this contract is to "...provide models and codes to predict infrared background phenomenon to be encountered by advanced space based systems operating in natural and disturbed backgrounds." To accomplish this goal, the contract was initially divided into four tasks:

1. MSX Data Analysis
- 2.1 Trace Species in MODTRAN
- 2.2 Radiance Inversion Techniques
- 2.3 Mesospheric Radiance Model

The contract was amended in December 1994 to add a new task:

3. FASE (FASCODE Environment)

However, soon after the beginning of the contract, it was discovered that the work specified for Task 2.1 Trace Species in MODTRAN had already been performed by another contractor and no further work was performed on this task. Task 2.3 Mesospheric Radiance Model was never funded so no work was performed on this task either.

The following sections will describe briefly the work performed on the remaining three tasks and refer to reports and publications where the work is described in detail. These publications are listed in Section 5 by task.

2. MSX Data Analysis

The Midcourse Space Experiment (MSX) is a satellite experiment originally designed to measure the faint background radiance in the earth's limb against which targets are to be detected. The principal instrument on MSX was SPIRIT III, a solid-hydrogen cooled interferometer with six detectors covering bands from 1.6 micrometers to 12 micrometers at a maximum spectral resolution of 2 cm^{-1} . MSX also carried a suite of visible and ultraviolet imagers and imaging spectrometers UVISI and the broadband visible imager SBV. A complete description of MSX is given in Mill et al., 1994 and Mill 1997. MSX was launched on April 26, 1996. SPIRIT III provided data from May, 1996 to March 1997 when the cryogen ran out. The UVISI and SBV instruments continue to operate.

Between the time of the instrument design and launch, interest changed from the strictly upper altitude limb (above 40 km) to include lower altitude limb (0 to 40 km) and below-the-horizon (BTH) backgrounds. In addition, it was realized that during the lifetime of MSX (originally projected to be between Nov., 1994 and May, 1996) it would be the only satellite capable of measuring trace gases in the stratosphere and would bridge the gap between the Upper Air Research Satellite (UARS) and the Earth Observation Satellite (EOS). AER's work was an extension of the work performed on a previous contract: "Development of Remote Sensing Algorithms for Atmospheric Variables from Radiometer Data-Phase II", Contract No F19628-91-C-0167, [Gallery and Moncet, 1994.]

AER's responsibility in the MSX program was to:

1. Prior to launch, prepare experiment plans for MSX observations of the low altitude limb, both for general surveys and for the retrieval of stratospheric trace gases,
2. During the cryogen phase (SPIRIT III is operating), prepare detailed monthly plans for data collection events (DCE's) for the experiments in 1.,
3. Develop the software for the automated analysis of the data from the UVISI sensors,
4. Provide for the analysis of auxiliary data from complementary sources, specifically, from weather satellites, to support the analysis of MSX data

AER created the following MSX experiment plans:

- ELE-4: Airglow Staircase Survey
- ELE-10: Vertical Profile Survey
- ELE-19: Stratospheric Trace Gas Survey

Early versions of these experiment plans were reported in Gallery and Moncet, 1994.

Detailed monthly plans for the DCE's belonging to these experiment plans were reported in Annual Scientific Report II, Gallery et al., 1998.

The development of the software for the automated analysis of the UVISI data was also reported in Annual Scientific Report II, Gallery et al., 1998. This software was delivered to the PL DAC in 1995.

Analysis of auxiliary data has been reported in numerous publications listed in Section 5.2. The most notable papers are: Picard et al., 1998, and Dewan et al., 1998.

3. Radiance Inversion Techniques

This task involved the development and testing of radiance inversion techniques that could be used to determine atmospheric physical and chemical properties from remotely sensed data. In particular, algorithms were developed to derive atmospheric trace gas amounts from radiometric data collected by the CIRRIS-1A experiment. CIRRIS-1A was flown aboard the Space Shuttle Discovery as part of the STS-39 payload in April 1991, and details may be found in [Ahmadjian et al., 1990].

AER's responsibility in the development of the retrieval algorithm included:

1. The development of a fast, accurate radiative transfer code to be used as part of the overall radiance inversion package.
2. The development of a robust inversion routine to estimate geophysical parameters from the measured radiances.
3. All design, implementation and testing of the algorithm modules.
4. Running of test cases with both simulated and real data.
5. Transfer of the retrieval algorithm to Dr. Steven Miller at Hanscom.
6. Provide expertise and results for technical papers and presentations.

The radiative transfer code ("XFWD") was developed from FASCODE and leveraged AER resources from other projects. The inversion module ("XINV") was based on Rodgers' (1976) optimal inversion technique. Simulations were done for a variety of scenarios, including

the limb-viewing geometry applicable for CIRRIS-1A. The results of these tests are documented in two refereed journal papers (Miller et al., 1999; Miller et al., 2000).

4. FASE

This task involved working directly with Gail Anderson (AFRL, Hanscom) to continue the development of the FASCODE radiative transfer algorithm. This new version was dubbed "FASE" (FASCODE for the Environment). The details of this algorithm and our effort on this task are described in Snell et al., 2001.

5. References

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